GEOLOGY
OF THE
LE BRUN AND MINT CANYON QUADRANGLES,
CALIFORNIA

by

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for the degree of
Bachelor of Science,
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Frontispiece. A view looking southward from the base of Sierra Pelona Ridge over the fans and terraces in Upper Mint Canyon.

"Frontispiece". Panorama looking over the Le Brun Quadrangle showing the matureland. Bee Canyon on left, Martinez wedge in center, and Clearwater Canyon on right.

INTRODUCTION

General Statement.

The Le Brun and Mint Canyon Quadrangles comprise an area of approximately fifty-two square miles. The northern part of the Le Brun Quadrangle is made up of three fundamental geologic units. Steeply dipping Tertiary sediments form a wedge, which narrows eastward, between an igneous complex to the north and a metamorphic series to the south. These rock units are all bounded by steep, northerly dipping faults. The faulting is post-Oligocene and pre-Pleistocene in age. Everywhere the faults are truncated by an old land surface which is several stages removed from some of the more progressive land forms of the present cycle. The southern part of the Le Brun Quadrangle is composed largely of the metamorphic series which forms Sierra Pelona Ridge.

In the northern part of the Mint Canyon Quadrangle, the sedimentary wedge is terminated by a series of intersecting faults which persist to the eastern edge of the area and continue into the San Andreas Rift, several miles east of the boundary of the Mint Canyon Quadrangle. The central portion of the Mint Canyon Quadrangle is formed by the metamorphic series and is expressed topographically by Sierra Pelona Ridge. In the southern part of this quadrangle, an intricate system of faulted igneous and

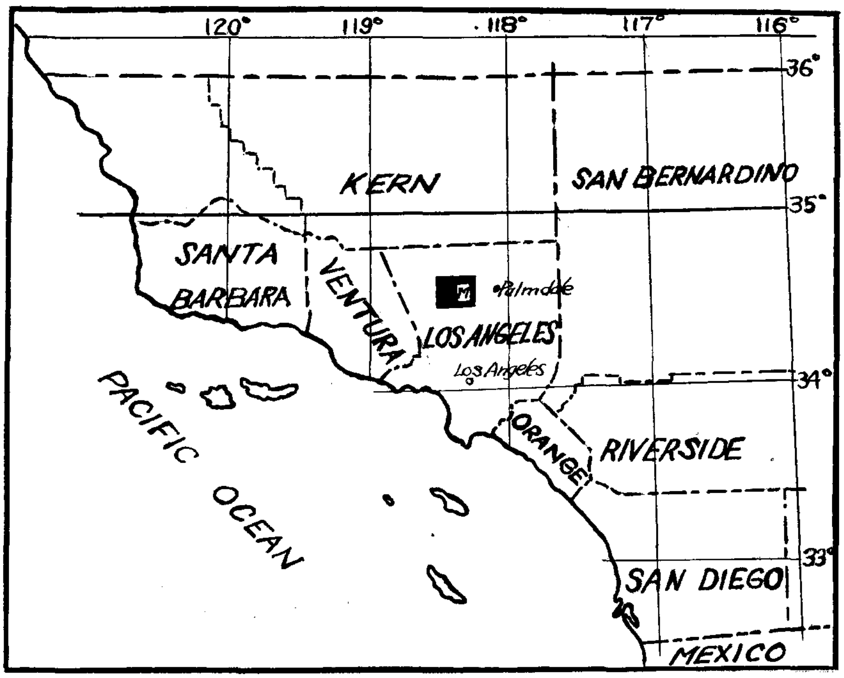


Fig. 1. Index map of southern California, showing location of Le Brun (B) and Mint Canyon (M) Quadrangle. The area outlined in red is covered in this report.

sedimentary beds are exposed. Easterly, this fault system disappears.

Location.

The Le Brun and Mint Canyon Quadrangles are located in Los Angeles County , thirty-five miles northwest of the City of Los Angeles. The area is situated twelve miles, by road, north of Newhall, the nearest center of population. Saugus, nine miles south, is the most accessible railroad station for the greater part of the area. The only community within the Le Brun Quadrangle is Clearwater which is often referred to as Power House No. 1. At Clearwater, several houses have been built for employees of the Bureau of Power and Light of the City of Los Angeles. Isolated farm houses and cabins are scattered over the area in choice canyon sites. A farming population inhabits Sierra Pelona Valley.

The Le Brun and Mint Canyon Quadrangles are bounded by thirty-four degrees and thirty minutes and thirty-four and thirty-six minutes north latitude and one hundred and eighteen degrees and eighteen minutes and one hundred and eighteen degrees and thirty minutes west longtitude. Both quadrangles are included within the smaller scale map known as the Elizabeth Lake Quadrangle. The Le Brun Quadrangle comprises the southwest corner of

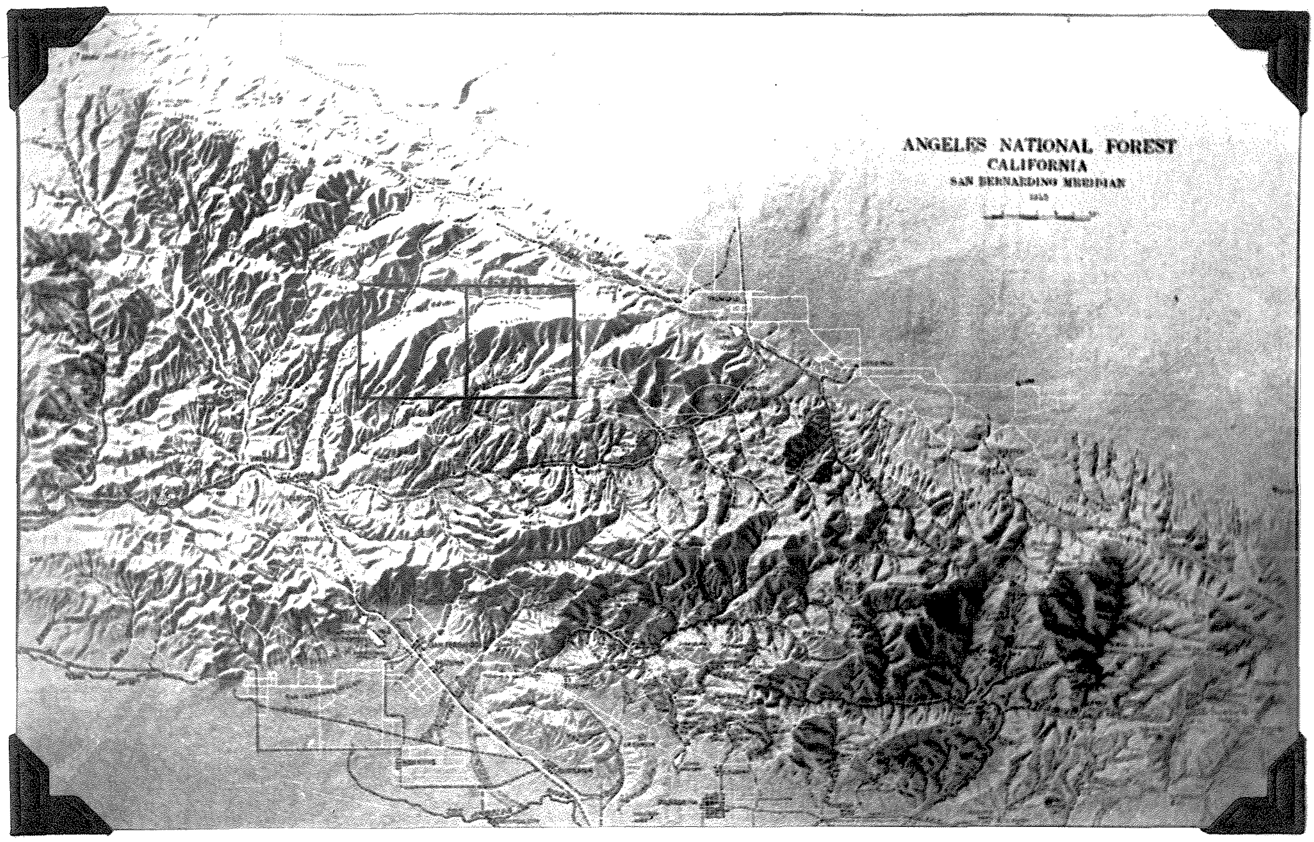


Fig. 2. Photograph of Relief Model of the Angeles National Forest showing the location of the Le Brun and Mint Canyon Quadrangles, California. Note also the moderate relief of Sierra Pelona Ridge. -Modified after M.A. Sedelmeyer

the Elizabeth Lake Quadrangle. The Le Brun Quadrangle, which the writer used as a base map, is an advance sheet, subject to correction, prepared by the United States Geological Survey in cooperation with the Surveyor's Office of the County of Los Angeles. The Mint Canyon Quadrangle has not been published, but the writer was able to secure a photostatic copy of the preliminary pencil drawings for field use. The Le Brun Quadrangle adjoins the Hughes Lake Quadrangle which lies to the north, the Lake Quadrangle which lies to the northeast, the Mint Canyon Quadrangle which lies to the east, the Lang Quadrangle which lies to the southeast, the Humphreys Quadrangle which lies to the south, the Saugus Quadrangle which lies to the southwest, the Red Mountain Quadrangle which lies to the west, and Warm Spring Quadrangle which lies to the northwest. East of the Mint Canyon Quadrangle is the Red Rover Quadrangle.

Conditions of Study.

Field work was carried on during the fall and winter of 1934 and the spring of 1935. A total of twenty days were spent in the field. The study was carried out under the direction of the Department of Geology of the California Institute of Technology. Laboratory investigations were conducted in conjuction with field studies at the California Institute. While approximately thirty square miles were mapped in preparation for this study in considerable detail, the writer feels that the work represents a rather thorough reconnaissance and appreciates the fact that further work will reveal more information.

Acknowledgments.

The writer is particularly grateful for the advice and criticism of Dr. John H. Maxson concerning the problems encountered in the field. The writer is also indebted to Mr. Jack Judson, who has carried out a similar investigation, for the many stimulating discussions to which he contributed. Approximately one third of the time devoted to field study was spent in the company of Mr. Judson.

Earlier Investigations.

The earliest record mentioning this area is found in two short papers by O. H. Hershey. He published short descriptions of formations found within the area in 1902. Until 1928, practically no attention had been given to the geology of this region when the disaster caused by the failure of St. Francis attracted world wide attention. A number of short reports and papers dealing with some of the problems involved in this region were issued during 1928 and 1929. Nickell wrote a thesis in 1929 on the San Francisquito Canyon sediments and the Clearwater Fault. The writer has found the contacts and structure mapped by Nickell to be unreliable. R. T. Hill's map is much more accurate but the writer is unable to justify the existence of several faults shown on his map. The structural interpretations of Clements in the adjoining quadrangle to the west conform with most of the writers present conclusions. In the October, 1934 issue of "The California Journal of Mines and Geology", Edward C. Simpson published a report on the "Geology and Mineral Deposits of the Elizabeth Lake Quadrangle, California". The scope of Mr. Simpson's investigation has permitted only investigation of the reconnaissance type. A complete list of publications pertaining to this area will be found in the accompanying bibliography.

GENERAL FEATURES

Surface Relief.

The surface relief of the Le Brun and Mint Canyon Quadrangles may be described as moderate except for several prominent fault line scarps. Sierra Pelona ridge has a gently undulating crest. Its highest summit attains a hight of 4950 feet above sea level at the eastern boundary of the Mint Canyon Quadrangle. Elevations as low as 1700 feet are found in San Francisquito Canyon at the western margin of the area. In general the terrain slopes southwest. Deep Canyons have been cut through Sierra Pelona Ridge and along fault planes in the northern part of the Le Brun and Mint Canyon Quadrangles. Most important of these canyons are Bouquet and San Francisquito Canyons. Terraces form an important element in the surface relief in Texas and Mint Canyons. The dissection of older land forms is responsible for much of the apparent ruggedness of this area.

Drainage.

Drainage from almost the entire area is southwestward into the Santa Clara River. San Francisquito Canyon, Dry Canyon, Haskell Canyon, Bouquet Canyon, Mint Canyon, and Texas Canyon all have intermittent streams which flow southwest. Irregular, east-west drainage lines are found paralleling the Clearwater fault in Clearwater, Cherry, and Upper Bouquet Canyons. Exceptions to the general conditions pointed out above are found on the eastern and western margins of the area where drainage flows east and west parallel to the Clearwater Fault into Leonis Valley and Elizabeth Lake Canyon respectively. In ordinary years both San Francisquito and Bouquet Canyons have some water in them throughout the summer months.

Climate and Vegetation.

A semi-arid climate prevails throughout the area. The rainfall records at Newhall, 12 miles to the south, shown a mean annual rainfall of 17.54 inches over a period of thirty-eight years. A minimum annual rainfall of 4.85 inches was recorded in 1877. A maximum annual rainfall of 44.20 inches is on record for the year, 1884. The rainy season begins in autumn and extends into late spring. In some years precipitation is confined to three or four important storms while in other years it may be the result of numerous minor disturbances.

At Newhall the mean annual temperature for a period of thirty-eight years is 61.5 degrees Fahrenheit. The minimum temperature for this station is 10 degrees above zero, and the maximum is 113 degrees over a twenty-two year period. Field work is always possible; although it may be disagreeable during the winter months because of snow on the ridges and because of cold winds of high velocity blowing in from the desert; and in spite of the fact that the sky is usually clear during the summer months permitting the field worker to acquire the full benefit of the sun's radiant energy.

The vegetation is typical of the Upper Sonoran life zone. In the wider canyons, oaks, sycamores, and cotton-woods are found in open spaces. Sage, greasewood, and manzanita grew prolifically on favored slopes rendering large areas almost incapable of penetration. On the higher ridges scattered junipers are sometimes found as well as in a few canyons in the Mint Canyon area. Locally, the contacts between formations are marked by changes in vegetation. In the spring months a beautiful display of California wild flowers is to be seen in the areas where sedimentary beds are exposed. Lupine, suncups, California poppies, and Indian paint bushes are common especially in Sierra Pelona Valley.

Potential Economic Mineral Deposits

Flagstone.

The Pelona schist is well adapted to quarrying since the bedding planes are parallel with the schistosity throughout this metamorphic series. Varities of flagstone consist almost entirely of quartz-mica schist and greenstone schist of varying degrees of hardness. Slabs sometimes 10 feet broad are readily quarried at several localities in Bouquet Canyon.

Talc.

There are numerous talc claims scattered over Sierra Pelona Ridge and in several of the more accessible canyons. Most of the talc contains actinolite and is colored green, and consequently is of little value. One mine in Bouquet Canyon was operating during the period which the writer spent in the field.

Graphite.

Graphite schist is found in the Pelona Schist series. It appears to be most abundant in the vicinity of San Francisquito Canyon. Coarse crystalline graphite is found as inclusion in partially granitized schists in the igneous masses north of the area.

Chromite.

Considerable high grade chromite float has been found over the surface of the ridge north of Bouquet Canyon, 13 miles north of Saugus. During the war, intensive prospecting failed to yield favorable results.

The float appears to have weathered out of serpentinized peridotite. This occurrence is reported in "Mining in California", volume 23, number 3, Pg. 286.

Gypsum.

Gypsum is found in narrow beds within the Sespe formation in San Francisquito Canyon. The presence of gypsum in the beds upon which the west abutment of St. Francis Dam was built was probably a contributing cause to the dam's failure. This gypsum is not present in large enough quantities to warrant commercial development.

Silver.

Silver has been mined in Texas Canyon. The Silver King Mine's operators developed ore in a mineralized quartz vein carrying galena and silver. A silver prospect has been reported to the writer as existing on the south slope of Sierra Pelona Ridge near the head of Mint Canyon. This occurrence consists of a talc deposit assaying values in silver.

Placer Gold.

Placer gold is sparsely distributed over a wide area south of Sierra Pelona Ridge. Deposits of auriferous gravels have been worked intermittently in Texas Canyon for over twenty years. Old terrace gravels and conglomerates within the Vasquez formation are washed. The channels in the terrace gravels have a northeasterly course and average about sixty cents a yard. Lack of water handicaps operations especially during the summer months.

Gold Bearing Quartz Veins.

The only important lode mine within the area is the Double Eagle Mine. A series of parallel quartz veins of varying widths occur in quartz monzonite. Ore consists of quartz carrying pyrite, calcopyrite, and gold. Surface workings yielded the richest ore. The mine has been idle for a number of years.

PHYSIOGRAPHY

General Features.

The mountainous area included within the Le Brun and Mint Canyon Quadrangles is the eastern most extension of the Transverse Ranges of California. According to Fenneman the San Gabriel Mountains are bounded on the north by the Santa Clara River and the Mojave Desert. The general east by north-east direction of Sierra Pelona Ridge is accordant with the Tehachapi Mountains, but is discordant with Liebre and Sawmill Mountains, which lie several miles to the northwest. Liebre and Sawmill Mountains are elongated in a northwest-southeast direction.

The summit of Sierra Pelona Ridge is a relict surface of late maturity. This mature land may be compared with similar surfaces on the summits of Liebre, Sawmill, and the Tehachapi Mountains, since all are

Fig.3. Undulating surface south of Cherry Canyon.

Fig.4. Matureland and Cherry Canyon fault gap looking southeast from Jupiter Mountain.

Fig. 5. Rounded topography west of San Francisquito Canyon.

Fig. 6. Smoothed ridges and spurs on Sierra Pelona Ridge.

roughly at the same elevation(5,000-6,000 feet) and of the same degree of relief(plus or minus five-hundred feet). Fenneman correlates the summit surface of the Tehachapi Mountains with the younger broad valley stage of the Sierran cycle, exemplified by Chagoopa Plateau.

Fault Controlled Physiography of the Northern Part of the Area.

All the major physiographic features in the northern part of the Le Brun and Mint Canyon Quadrangles are marked by faults. The Clearwater Fault is responsible for the erosion of Clearwater, Cherry, and Upper Bouquet Canyons in an east-west direction. The position of ~~the~~ Bee Canyon as well as San Francisquito Canyon are determined by faults. A remarkable feature prevails throughout this part of the area. The actual fault plane is almost always to be found several hundred feet up the northern wall of these canyons. Evidentally after initial erosion had adjusted stream courses to the fractured zone of the fault, the streams either cut more rapidly down the dip of the sediments or eroded the softer beds causing a displacement to develop between stream courses and fault lines. Splendid examples of fault gaps are found at the west end of Clearwater and at the east end of Cherry Canyon. Between Clearwater and Bee Canyons, San Francisquito Canyon

Fig. 7. Subdued topography looking over San Francisquito Canyon. Clearwater Fault gap on skyline.

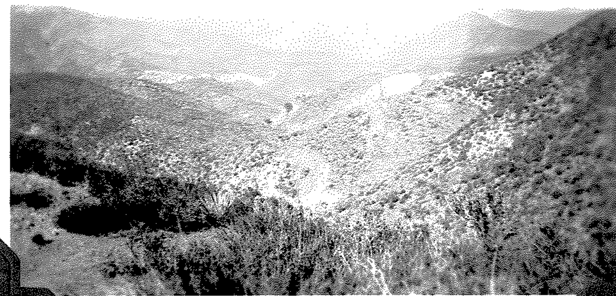


Fig. 8. Sierra Pelona Ridge from Texas Canyon. Light patch in middle distance marks position of Pelona Faul

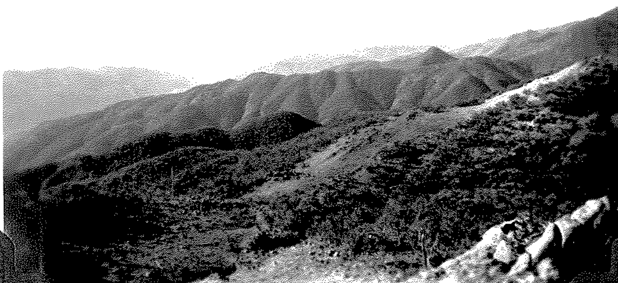


Fig. 9. Typical physiography of the Martinez section exposed at the western edge of area.

Fig. 10. Terraces on the slope of Sierra Pelona Ridge, San Francisquito Canyon.

Fig. 11. Drinkwater Flat showing the broad valley developed by an ancient stream.

Fig. 12. Terraces in Upper Texas Canyon.

Fig. 13. Broad fan and terrace slope seperating Mint and Texas Canyon drainages.

represents the course of an antecedent stream since it is not adjusted to the structure in this part of its course. Bouquet Canyon in the lower part of its course is likewise an antecedant stream. All the streams within the area show evidence of renewed cutting due to uplift. At the east end of Bouquet Canyon Reservoir beaded ridges form~~ing~~ islands and aligned hills along the strike of several faults.

Sierra Pelona Valley.

The wide valley which is situated north of Vasquez rocks contains large areas of alluvium on the slope of the fan descending from Sierra Pelona Ridge. This fan has been subsequently dissected into a number of terraces and broad valleys.

A Wave Cut Terrace.

A wave cut terrace of a great deal of significance to a geologist studying this area is found on the northern shore of Bouquet Canyon Reservoir. The terrace has been cut 15 feet high since the dam has been placed in use. This exposure is the most easterly outcrop of the Martinez formation.

An Old Land of Late Maturity--Sierra Pelona Ridge.

One of the most significant physiographic features within the area is the ~~presence of an~~ old land of late maturity forming the summit of Sierra Pelona Ridge. An almost horizontal skyline marks the profile of

Sierra Pelona Ridge when viewed from the south. The summit of the ridge is broadly concave forming considerable areas of level land. An area of gently rolling hills and undulating slopes is found on the sides of Sierra Pelona Ridge as well as on the wedge of Martinez sediments between Cherry and Bouquet Canyons. This subdued surface slopes about 250 feet to the mile southwesterly. Clements has postulated this tilt to be the result of a comparatively late movement in Middle Pleistocene time. The writer is not so confident that this has taken place and feels that the whole area has been bowed up in fairly recent time. The gentle slope of the higher ridges is probably a relict surface of the old land. Dr. Maxson has suggested that Sierra Pelona Ridge might be an eastward continuation of Anacapia, a positive area in the historical geology of California as far back as Franciscan time.

Drinkwater Flat.

There is good evidence to believe that Drinkwater Flat marks a stage in the physiographic cycle of this region. This Flat is obviously truncated by San Francisquito Canyon where it forms a hanging valley with reversed drainage. Drainage is southward into Dry Canyon. At the head of Dry Canyon the course of the intermittent stream is offset and makes a drop of several hundred feet from the level of Drinkwater Flat.

Unquestionably this flat marks an old channel of drainage off of the mature land after dissection of this surface had begun. It is too far below the average elevation of the old land to represent an initial consequent stream flowing off of this surface. A series of high terraces in San Francisquito Canyon can be roughly correlated with the level of Drinkwater Flat. The writer does not agree with Clements in assigning all the terraces in San Francisquito Canyon to the results of landslide activity. Undoubtedly there are many land forms which are landslide blocks, but these are terminated against the hillsides by crescent-shaped depressions. The slope is usually toward the mountain side on a landslide block and away from it en a stream terrace. The surface of a landslide mass is hummocky in contrast to the smooth surface of stream terraces. In Bouquet Canyon hummocky flats formed by several large landslides can be distinguished.

Terraces.

At a latter stage in its development San Francisquito Canyon appears to have been a stream which flowed westward over the soft Sespe beds to Elizabeth Lake Canyon. A number of terraces at the expected elevation can be traced to this gap.

A low level of terraces is found in San Francisquito

Canyon at a height of about 15 feet above the present stream bed. Numerous waterfalls throughout the area are believed to be contemporaneous with this low level of terraces. There seems to be no alternative to the hypothesis that the entire region has been bowed up or increased rainfall has resulted in greater erosion in recent time. The writer can justify only the hypothesis of a gentle uplift of the entire region since differences in rainfall cannot be great enough to materially alter conditions, since a climate similar to the present appears to have prevailed as far back as Miocene time.

In Texas and Mint Canyons extensive areas formed by terraces are preserved. These terraces are a combination of fan and stream accumulation. Fans merge without any differentiation into true terraces. The highest terrace marks the divide between Texas and Mint Canyon drainage basins. A single level of stream terraces is found in lower Texas Canyon. All of these terraces are likewise dissected by the headward-cutting of streams at lower levels. Through Mint Canyon gorge this level of terraces can be traced. The most remarkable feature is a perfectly preserved wind gap near the head of Mint Canyon just north of the old highway. At this locality the former eastwest course taken by the Mint Canyon drainage has been captured by the southern tributary of the Mint Canyon drainage following the highway. This feature as well as the widespread extent of terraces suggest that Texas

Canyon may have drained upper Mint Canyon at an early stage in its history. Undoubtedly this extensive development of terraces represents a long period of deposition and accumulation. Probably these processes were ~~in~~ active when San Francisquito Canyon began to achieve its present course.

The physiographic cycle of the Le Brun and Mint Canyon Quadrangles may be summarized in the following stages:

1. The matureland forming Sierra Peloan Ridge developed from a preceeding topography.

2. The erosion of a valley and the subsequent filling of this valley to form Drinkwater Flat.

3. Drainage to the west out of the San Francisquito Basin into Elizabeth Lake Canyon by means of a stream over the soft Sespe Red beds.

4. The accumlation of fans and terraces in upper Texas and Mint Canyons.

5. The formation of a low level of terraces in San Francisquito Canyon and of numerous waterfalls.

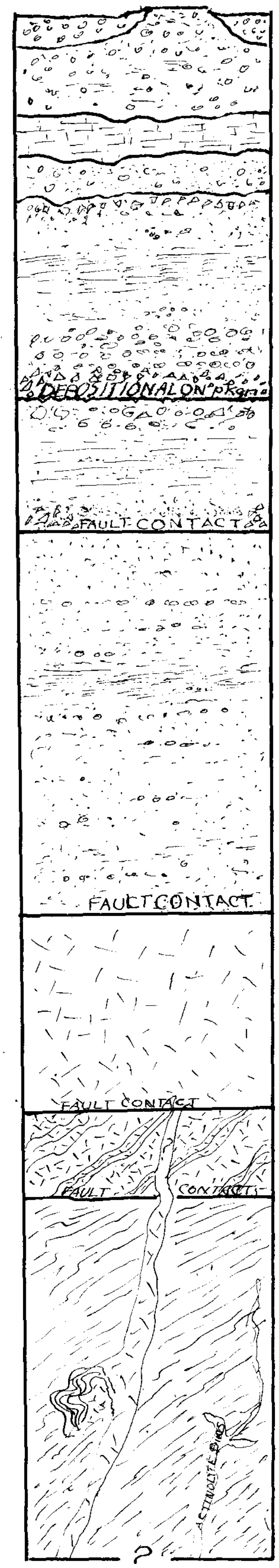
6. The present period of dissection of terraces and the headward erosion of streams with the typical trellis pattern of middle youth following the cutting of Mint Canyon gorge.

GEOLOGIC FORMATIONS

General Statement.

Representatives of all of the fundamental rock units are to be found within the Le Brun and Mint Canyon Quadrangles. Large areas of intrusive igneous rocks are exposed, and a small patch of extrusive lava is located in the southeastern corner of the area. The northern part of the area is largely granitic with some inclusions of schist. The central part of the quadrangles comprising Sierra Pelona Ridge is made up of a thick section of metamorphosed schists derived from old sediments of possible Cambrian Age. Sedimentary deposits of marine, lacustrine, and fanglomeratic origin have been recognized. Extensive areas of terrace material have been mapped. The absence of fossils in the formations exposed within the area make questionable lithologic correlations the only basis for the stratigraphic succession presented in the adjoining, tenative stratigraphic column. A remarkable series of thick formations are exposed within the area which attain a thickness of approximately 21,000 feet.

SYSTEM	FORMATION	SYMBOL	COLUMNAR SECTION	THICKNESS IN FEET	CHARACTER AND DISTRIBUTION
Recent	Alluvium	Qal		50	Fanglomerate, gravels, and silt.
Pleistocene	Terrace Alluvium	Qal		100	
Miocene	Lava	Tl		20	Basaltic lava flow.
Upper Miocene	Mint Canyon	Tmc		complete section not exposed	Buff colored sandstone and conglomerate.
Middle Miocene	Vasquez	Tv		7500	Alternating red beds, sandstones and conglomerates.
Oligocene	Sespe	Ts		3000	Interbedded gypsiferous red beds and conglomerates.
Paleocene	Martinez	Tm		8500	Interbedded marine sandstones, shales and conglomerates.
Jurassic	Monzonite, Diorite	Jm			Igneous complex.
Pre-Cretaceous	Gneiss	pKgn			Microcline-biotite gneiss.
Pre-Cambrian	Pelona Schist Series	pCp			Greenstone and mica schists.



Metamorphic Series

Pelona Schist Series.

General Features.

Forming the main body of Sierra Pelona Ridge and covering the largest area of any of the formations exposed within the Le Brun and Mint Canyon quadrangles, the Pelona Schist Series is a very important unit. It has a thickness of approximately 9,000 feet. The schistosity is parallel to the bedding throughout the series except where it has been obscured by subsequent folding and faulting. The series is believed to be of paragenetic origin and is the result of the metamorphism of a conformable series of medium and fine grained sedimentary beds. The Pelona Schist Series consist of mica schist, greenstone schist, actinolite and talc schist, quartzite, and limestone. The lower part of the series forms the south slope of Sierra Pelona Ridge and is predominately mica schist. The upper part of the series comprising the northern slope of Sierra Pelona Ridge contains numerous horizons of greenstone schist. Quartzite, talc, and actinolite beds are found throughout the sequence of metamorphic beds. Limestone deposits are most abundant in the lower part of the section especially in Texas Canyon. The mica schist weathers to a dull reddish-brown sand while the greenstone schist forms a soil characteristically maroon colored. The beds in the Pelona Schist Series strike parallel to Sierra Pelona Ridge at approximately N 80 degrees E and dip away from the crest of the ridge forming a broad anticline.

Mica Schist.

Consisting dominately of albite, quartz, and muscovite with subordinate amounts of biotite, the mica schist is the most abundant rock type of the Pelona Schist Series. This schist is consistent in composition and texture throughout the lower part of the section. The rock is fine grained and shows a remarkable parallel orienatation of mineral grains and occassional augen structures. The most probable explanation of the origin of these beds is that they represent an accumulation of marine silts and arkosic sandstones which have been subsequently metamorphosed. The presence of interbeds of limestone quartzite, and graphite schists within the mica schist series is excellent evidence to support this view. Simpson also considers the possibility of a metamorphosed sequence of volcanic rocks developing the present schist.

Greenstone Schist.

The dominant schist within the northern part of the area is a greenstone schist composed of albite crystals embedded in a groundmass of green minerals, epidote, green tourmaline, and chlorite. Simpson views this rock as having been derived from basic igneous rocks, probably"a series of basaltic lava flows with associated tuffs."

Quartzite and Quartz Veins.

Although occuring most abundantly in the upper part of the series, quartzites are by no means restricted to any part of the section. The quartzite is uniformily fine grained and almost always thin-bedded. In contrast, vein quartz has a granular texture and is lenticular in plan. Such "quartz blowouts" form conspicuous local features.

Talc and Actinolite Schist.

Impure talc bodies are of frequent occurence in the Pelona Schist Series. This type of schist occurs as sills, dikes, and along fault planes. It is frequently associated with a border phase of actinolite schist, and occassionally with mariposite schist, a chrome-mica schist. As Simpson points out, these bodies have resulted from the hydrothermal metamorphism of dikes and sills of peridotite.

Type of Metamorphism.

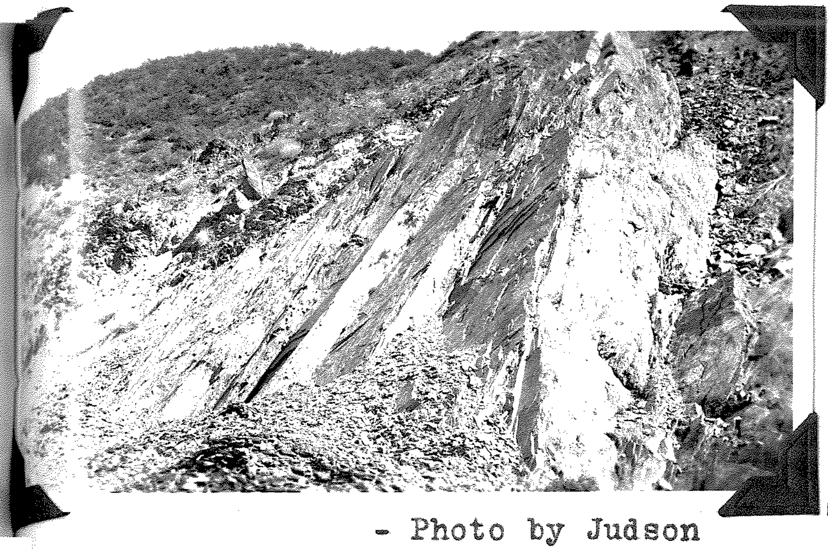
Although there is no marked difference in the degree of metamorphism within the series, local areas have undergone intense deformation. At several localities, ptygmatic folding can be observed. No relict minerals are preserved in the schists. They are completely recrystallized and are distinguished by a high soda content. These features suggest regional metamorphism at considerable temperature and pressure in the Biotite Zone accompanied by local dynamic stresses.

Fig. 14. Injection Gneiss within Pelona Schist Series, Upper Bouquet Canyon.

Age and Correlation.

Hershey, first, attempted to correlate this formation with certain schists in Northern California of Pre-Cambrian age. Generally later writers have designated the series as pre-Jurassic. Simpson states the following case in support for his view that the Pelona Schists were metamorphosed in ~~the~~ Pre-Cambrian-time," the Lower Cambrian rocks of the Inyo Range, 100 miles to the north; the Paleozoic rocks of the nearby Randsburg quadrangle; and the lower Cambrian rocks of the eastern Mojave Desert near Cadiz are either unmetamorphosed, or have been only locally metamorphosed by igneous intrusions; in the lower part of the Paleozoic section in the Randsburg quadrangle, Hulin found detrital fragments of the Rand Schist, correlative of the Pelona Schist Series." While the writer considers the first part of this argument invalid, he likewise feels that the second bit of evidence is too conclusive to refute since the idenity of the Rand and Pelona Schists is most convincing. The writer therefore considers this series to be Pre-Cambrian.

A review of the literature brought forth the following information. In Hill's report, Tolman is quoted as considering that the Schist series at the dam site was derived from granite. Ransome, Louderbach, and Willis have described these rocks as mica schists. Clements and Nickell consider them



- Photo by Judson

Fig. 15. Pelona Schist in San Francisquito Canyon by Power House No. 2.

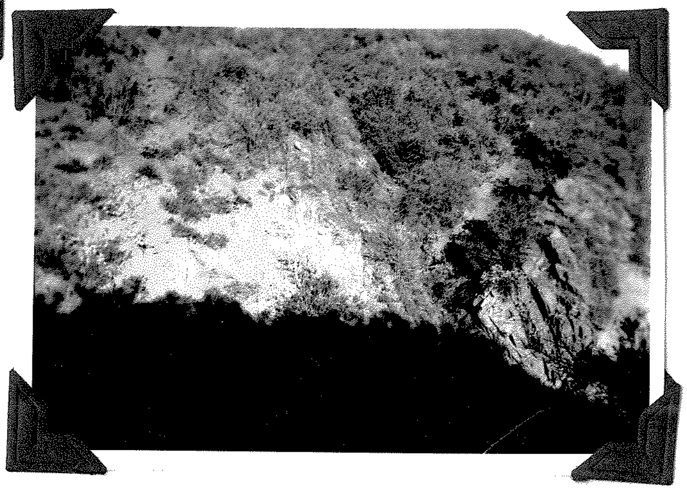


Fig. 16. Pelona Schist dipping southward, Haskell Canyon

Fig. 17. Microcline-Biotite Gneiss, Upper Mint Canyon.

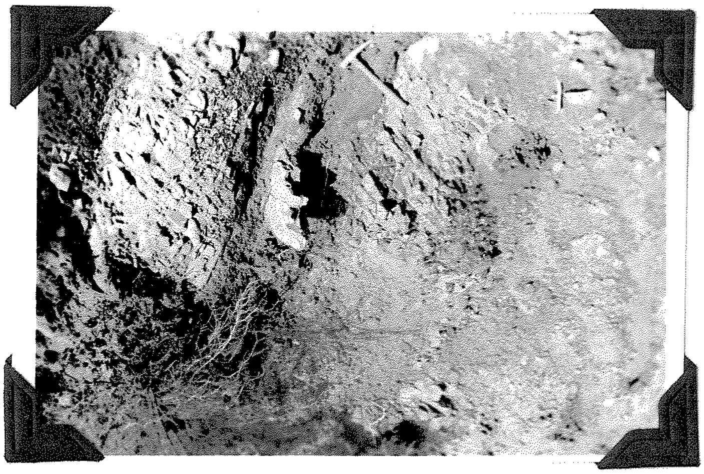


Fig. 18. Small fault within Martinez sandstone, Bee Canyon Ridge.

as developing from the metamorphism of sediments.

Gneiss.

Two distinctive and genetical different gneissic units have been recognized by the writer. One consists essentially of injection gneiss which is best exposed in the northern part of the area. The other unit is a microcline-biotite gneiss and is exposed in Texas Canyon.

Injection Gneiss.

Striking parallel to the Pelona Schist, the injection gneiss represents granitized inclusions within the northern igneous body. In the southern part of the area a quartz-monzonitic body forms an irregular contact north of Sierra Pelona fault evidencing gradational granitization away from the schist body. Occassional lit-par-lit structures are developed. Contorted injection gneiss can be best observed on the surge tank road. These gneissic bodies are ~~of~~ irregular in outline and are sometimes present as blocks within the igneous mass. The igneous units with good sized hornblende crystals have the smallest number of inclusions. Zones of biotite mark areas of gneissic inclusions within the igneous body. The general lithology of this gneiss is suggestive of the Placenta formation of the San Gabriel Mountains.

Microcline-biotite gneiss.

A sample of this rock is unmistakable when recognized in the field. Lithologically, the rock consists of large augen of pink microcline embedded in a fine grained groundmass of biotite, quartz, and andesine. The augen are oriented parallel to one another in the dark groundmass. This unit is exposed in a number of east-west fault slices in Texas and Upper Mint Canyons. The writer has mapped an irregular north-south contact which he considers to show the relationship between the microcline-biotite gneiss and everlying formations. This contact is apparently depositional. Further evidence supports this view. A coarse angular conglomerate composed essential of fragments of schist is found in fault contact a few hundred yards to the northeast beautifully exposed in a road cut. This is basal Vasquez. A chilled phase of this augen gneiss has been recognized in Texas Canyon. It weathers to a characteristic gray green and is exceedingly fine grained. Its relationships are obscured by faulting. Some exceptionally fine grained basic dikes are also found within the exposures of microcline-biotite gneiss.

Igneous Series

General Features.

The differentiation of units within the igneous body is unwarranted from observation in the field. All the granitic igneous types appear to be allied mineralogically and to represent differentiates of a single magmatic body. Within a continuous igneous body the writer has observed changes from Quartz Monzonite to Diorite indicating the extremable variable composition of these units. The presence of the minerals of biotite and hornblende is the chief distinction in the field between these different rock types. Irregular graduational contacts marks the seperation of one unit from the other. Basic dikes are found at several localities.

Quartz Monzonite.

A faulted wedge of igneous rock occuring north of the Sierra Pelona Fault has been recognized as a quartz monzonite in a thin section prepared by the writer. Simpson designates this unit as a quartz diorite.

Monzonite.

South of Mint Canyon is a large mass of igneous rock. It is predominately monzonitic. Some beds of gneiss can be clearly seen also in the cuts beside the old road in Mint Canyon. The monzonitic mass is of variable composition containing often both hornblende and biotite. Granites were also recognized in the field. Muscovite is the dominant mica in the granite. Aplite dikes cut through the igneous body in different directions.

Granodiortite.

A fresh sample of most of the igneous rocks exposed within the area is difficult to secure. A sample collected on the dumps below the surge tank turned out to be a granodiorite after examination in thin section. Even this rock is considerably altered. Prominent crystals of green hornblende are characteristic of this rock. The texture is coarse to medium grained. Simpson mapped this locality as quartz monzonite.

Diorite.

A considerable area of dioritic rocks covers Jupiter Mountain. Hornblende is the dominant mafic constituent. Biotite is sometimes found. The rock is very coarse grained and weathers deeply. This diorite grades inperceptibly into the granodiorite exposed by the surge tank. Along the Clearwater fault these rocks have been extensively altered. Epidote and chlorite are frequently found indicating hydrothermal alteration.

Basalt.

Several basaltic dikes were noted within the microcline-biotite gneiss in the Mint Canyon Quadrangle. The exceedingly fine grained texture of this rock is evidence of its intrusion into the igneous body after it had cooled off. These dikes are probably contemporaneous with flows farther south in the Lang Quadrangle of Miocene age.

At the extreme southeastern corner of the area outcrops of lava flows are exposed on the surface. These flows continue into the Lang Quadrangle.

Age and Correlation.

The age of this intrusive body is difficult to determine because of its fault relationships with overlying rocks. Within the area the only evidence indicates that the igneous body is post-Pelona schist, post-Cambrian, and pre-Vasquez, or pre-Eocene. Hershey looked upon these rocks as continuous with the batholith of the Tehachapi Mountains and the Mojave Desert, and therefore as intrusions between the latest Jurasic and earliest Cretaceous sediments. The granuluation of these igneous rocks is markedly different from other early Cretaceous intrusions. W. J. Miller suggests that the older granitic rocks may be pre-Cambrian or Archean in age. Simpson points out that no evidence has been unearthed to prove that these rocks are older than the Mesozoic, or that they are not correlatives of the Sierra Nevada Rocks. The writer has discovered evidence which at least limits this upper boundary.

SEDIMENTARY SERIES

General Features.

Forming a wedge of sediments between metamorphic rocks to the south and igneous rocks to the north, a thick section of sedimentary beds is exposed at the western edge of the Le Brun Quadrangle. This wedge is composed of two seperate formations of questionable age, which are tentatively assigned to the Martinez and Sespe. In Texas Canyon a considerable thickness of Red Beds is exposed which appears to be correlative with the Vasquez formation. The Mint Canyon formation outcrops in the southwest corner of the Le Brun Quadrangle and in Texas Canyon.

Paleocene Rocks

Martinez Formation.

Distribution.

The Martinez formation is a long narrow fault block forming a wedge between the Bee Canyon and Clearwater Faults. It widens westward and extends into the Tejon Quadrangle where it has been mapped by Clements. Eastward it is terminated by the intersection of the Clearwater and Bee Canyon Faults on the north side of the Bouquet Canyon Reservoir in the Mint Canyon Quadrangle. The general strike of the beds is N 70 degrees. The beds have been tilted and now dip at steep angles most frequently to the south. The southern part of the section is the upper part of the formation implying that the section has been locally overturned. The total thickness of the formation within the area is in excess of 8,500 feet. Clements has recognized a section 10,000 feet think to the west. A small slice of Martinez has been brought up by the San Francisquito Fault in Bee Canyon south of the Sespe formation.

Petrology.

The most striking feature of the Martinez is its irregular character. Lenses of conglomerate are found within shale beds. Both the bottom and top of the section contain numerous beds of shale. A think bed of coarse conglomerate can be traced through the middle of the section. Buff colored sandstones containing approximately equal quanities of angular quartz and feldspar fragments are the most abundant beds within the section. Both siliceous and calcareous cement is found binding the grains together. The grains are always subhedral to anhedral. Sometimes they are extremely angular. Biotite and green hornblende are the dominant mafic minerals. The sandstone is commonly coarse grained. The conglomerate facies is made up of subrounded fragments and contains approximately 70% of granite and gneiss, 20% of felsite, and 10% of quartzite. Some fragments are found as large as four inches in diameter. The larger boulders are usually well rounded while the smaller peebles are subrounded to angular. A remarkably uniform conglomerate bed approximately 150 feet thick ~~conglomerate bed~~ has been traced across this section. Lenses of conglomerate are scattered throughout the formation and are frequent within the sandstone beds. In many of the stream beds, which have been cut through the Martinez, are extensive coatings of lime and iron compounds. These accumulations are the result of leaching of the Martinez beds. On the ridge between Bee and Cherry Canyon the writer has collected several hematite casts out of the sandstone. Some of the dark brown shale beds are exceedingly fine grained and contain leaf imprints, pyrite, and carbonaceous material. The only other evidence of organic life observed in the field consisted of worm tracts. The shales are thin bedded and the sandstones vary from massive to thin bedded. Cross bedding is sometimes seen in the sandstone.

Conditions of Deposition.

Since these sediments are rather fresh and the feldspars are well preserved, the climate under which these sediments accumulated must have been arid, or they were quickly carried ~~(fragments)~~ to the sea. The presence of carbonized wood and the coarseness of sand grains indicates deposition not far from shore in a rather humid climate. The Eocene is generally recognized as the most humid climate which the Pacific Coast has experienced; hence, these sediments appear to have accumulated close to shore after a short period of transportation from an area of rather high relief in a warm climate. The writer considers a marine fault basin not far from shore the most probable place of deposition since it explains most of the evidence.

Age and Correlation.

The evidence of the Martinez age of these sediments is now quite conclusive. The marine origin of the beds is proved by the presence of invertebrate fossils which have been collected in the Tejon Quadrangle and of foraminifera. The invertebrates were described by Clements. He found a fragment of a Natica and three whorls of a Turritella which he considered to be a likely Eocene form. Simpson collected in the shale beds some casts of foraminifera, one of which was determined by Schenck to be a costate "Nodosaria," an Eocene or Paleocene form.

A survey of the literature shows that this formation was first described by Nickell as Martinez. Hill refers to them simply as Eocene after Gale. The writer prefers to consider the Martinez Paleocene following Reed and Woodring.

Oligocene Rocks

Sespe Formation.

Distribution.

Forming a thin fault slice which widens into a 7,000 foot section in the adjoining Tejon Quadrangle, Sespe beds are well exposed in San Francisquito Canyon and continue for approximately one mile up Bee Canyon to the intersection of the San

Francisquito Canyon and continue for approximately one mile up Bee Canyon to the intersection of the San Francisquito and Bee Canyon Faults. A thin slice about 50 feet across has been faulted up south of the Martinez block on the San Francisquito Fault. The beds have a strike of approximately N 80 E; although many minor structures are developed within the formation obscuring this relationship. Moderate dips are most frequent.

Lithology.

This formation consists of shales, siltstones, and conglomerates and is characteristically a reddish-brown. Cementing material is generally lacking but may be represented by limonite or some other ferruginous bounding clay matrix. Gypsum beds are frequent in the siltstones and fine conglomerates and are sparsely present throughout the formation. In connection with the St. Francis Dam disaster, the beds underlying the west abutment of St. Francis dam were extensively investigated. Tests revealed that the well rounded pebbles embedded in a matrix of oxidized ferruginous clay and angular sand disintegrated to a mud when immersed in water. Lime is also found as an authigenic constituent. The sandstone beds average several feet in thickness while the shales are thin bedded. The Sespe formation appears to be right side up with the lower section represented along its southern boundary

Fig. 19. Well cemented, gray Vasquez conglomerate, Upper Mint Canyon.

Fig. 20. Sespe Red Beds, San Francisquito Canyon.

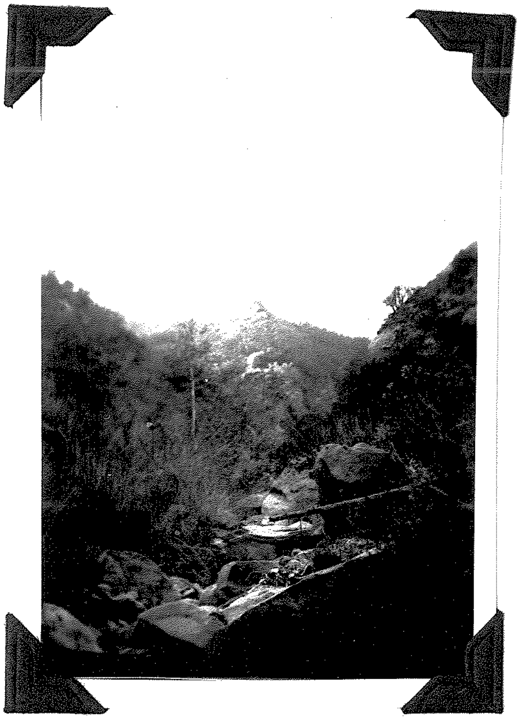


Fig. 21. Erosional knob typical of weathered Martinez west of San Francisquito Canyon.

by a course conglomerate as the basal facies. While this basal section is not well exposed within the area, Clement's observations are worthy of mention. The proportion of peebles to matrix is markedly increased toward the south until the facies resembles a solid mass of granite in place except for occassional water worn boulders on the surface. Evidently extremely large blocks of igneous rock compose these basal beds. The upper Sespe beds are dominately siltstones and shales, although occassional conglomerates are found. Ripple marks and cross bedding offer a means of determining the top of the section beside the ordinary gradation from coarse to fine and truncated lenses. Sheared peebles are frequently encountered in the conglomerates. In Hill's report he considered 52% of the peebles to have been derived from metamorphic rocks consisting of granite, slate, quartzite, vein quartz and rhyolite, 40% were classified as a dense sandstone cemented with calcite, the remainder were too highly altered to classify. Worm tracts were the only evidence of life seen within the Sespe formation.

Conditions of Deposition.

The basal conglomerate was deposited at the foot of an abrupt fault scarp from a source to the south. This fact indicates a continuation of conditions which marked Martinez deposition, mainly local accumulation within a fault basin. This scarp seems to have been rapidly worn down under continental conditions and finally the playa accumulations are superseded by lacustrine and deltaic deposits in the upper part of the formation. The well bedded sandstones and shales indicate deposition in strong currents of water as Reed has pointed out. The cross bedding, which has already been noted, indicates deltaic deposition. The presence of gypsum favors the conception of a large inlet occassionally open to the sea. Evidently as the fault block subsided it came to rest below sea level and allowed the sea to enter. Ripple marks and mud cracks indicate deposition in a shallow arid basin. Tricounters were also collected from this formation and are added evidence of arid climate. The reddish brown color of the beds indicates considerable weathering under continental conditions before final consolidation and may be due to intermittent aridity within the basin between invasions by the sea.

Age and Correlation.

Bounded on all sides by faults and almost devoid of organic remains, any age determination of this formation must be based on lithologic correlations. The lithologic similarity with the type Sespe and its close proximity to the type section are the main reasons for assigning this formation to the Sespe. The writer believes that this formation was laid down in an independent basin and is in no way related to the Texas Canyon red beds which show distinctive lithologic differences. A positive area paralleling Sierra Pelona ridge is believed to have separated these basins as far back as Oligocene time. The type Sespe of Santa Clara Valley is of lower Miocene, Oligocene, and Eocene age.

Miocene Series

Vasquez Formation.

General Statement.

Exposed over a considerable area in Texas Canyon and in Mint Canyon, a 7,500 foot section of this formation has been recognized. Although numerous fault slices of igneous rock occur across the section, a repetition of beds was not observed in the field. The strike of the beds varies approximately 10 degrees north or south of the east-west direction. The dip of the beds is dominately southward apparently the result of a structural anticline which is cut off near its crest by the Sierra Pelona Fault. Eastward the Sespe beds are lost under terraces until the faults of Sierra Pelona and Mint Canyon intersect and the Sespe beds are "pinched out." At one locality Vasquez beds are found in depositional contact with the microcline-biotite gneiss.

Lithology.

The Vasquez formation exposed within the area consists dominately of conglomerates, some sandstone, and a few shale beds. This formation shows extreme lithologic variations within comparatively short distances, especially toward the east. Two distinct types of conglomerate were noted. The brick-red conglomerate is most common in

Texas Canyon while a gray conglomerate is most frequent in the Mint Canyon exposures. The gray conglomerate is well cemented with calcite and contains boulders up to five inches in diameter. Boulders of olivine basalt were found in this conglomerate. There source is probably to the south in the Lang Quadrangle. The gray conglomerate is composed of roughly 35% gneiss, 30% microcline-biotite gneiss, 10% anorthosite, 10% granite, and 15% andesite and felsite. The fragments are subrounded on the average but vary from angular to rounded. These cemented conglomerate beds weather to rounded topographic forms which are highly characteristic. The brick-red conglomerates are poorly cemented and are made of fresh pebbles which are stained red on the surface. Anorthosite and lava fragments are also found in these beds. A local basal conglomerate was observed in the field. Extremely angular fragments of microcline-biotite gneiss make up this facies which gradually grades into red Vasquez beds to the north. Some of the coarse sandstone and shale beds are well cemented with limonite. The sandstone contains both quartz and plagioclase fragments. Sandstone beds sometimes show good bedding while the shales are thin bedded. The conglomerates show little stratification. No evidence of organic life was found in this formation.

Conditions of Deposition.

Evidently this formation was also deposited in a fault basin at the base of a rising scarp. The extensive development of conglomerates is probably best explained by postulating extensive fan slopes upon which these sediments were laid down. Periodic uplifts along the fault scarp account for the recurrent conglomerate beds in the formation. The silts and sandstones were laid down in playa basins. The presence of lava and anorthosite boulders indicates a highland to the south and east as the source from which this material originated. The abundance of magnetite and ilmenite in the granitic area to the south may account for the source of ferruginous cement giving these beds their red color. The absence of Pelona Schist fragments within the Vasquez formation is good evidence to support this view. As a result of insufficient evidence, Simpson believed these sediments as having originated to the north and east rather than from the south. Undoubtedly Sierra Pelona Ridge was an area of low elevation during this period of deposition.

Age and Correlation.

The difficulty which one experiences in the field in distinguishing between certain Vasquez and Mint Canyon beds is evidence of their close idenity in time. The distinguishing feature is the presence of fragments of Pelona Schist in the Mint Canyon formation. In the Santa Clara valley section, the Mint Canyon lies unconformably upon the Vasquez. Since no lava flows are known to date back earlier than Middle Miocene time, the

Vasquez formation has been assigned to this period.

The writer does not think that this formation is related to the San Francisquito Canyon red beds because they are lithologically and stratigraphically different. Lithologically, anorthosite is present in the Vasquez formation and absent in the Sespe Formation, gypsum is quite abundant in the Sespe formation and lacking or absent in the Vasquez formation, well cemented conglomerate beds are lacking in the Sespe formation, and lava fragments are much more common in the Vasquez formation. Stratigraphically, sandstone beds are much more frequent in the Sespe formation, and most important in the Sespe formation there are thick basal conglomerate beds while in the Vasquez section conglomerates are probably at the top of the section and sandstones at the base.

The name Vasquez has been applied to this formation indicating that these rocks are similar to the formation exposed at Vasquez rocks. The indiscriminate use of "Escondido Series", originally applied by O. H. Hershey in 1902 to a succession of volcanic and continental deposits in Escondido Canyon south of Sierra Pelona Valley, is unwarranted and for this reason the more specific term, Vasquez formation, has been used to designate the Texas and Mint Canyon red beds. Kew was the first worker who attempted to correlate the Escondido Canyon and Texas Canyon rocks with the Sespe formation. Kew based his tentative correlation on lithologic similarity and proximity to the type section. Later workers including Simpson have preferred to retain the earlier name, Escondido formation. Simpson considers the Escondido formation to be closely related in age and lithology to the Topango formation.

Mint Canyon Formation. Upper Miocene.

Exposed only in the extreme southwest corner of the Le Brun Quadrangle, the Mint Canyon formation is composed of coarse grained buff sandstone. Pelona schist fragments are found in these beds indicating that Sierra Pelona Ridge was a positive area in Upper Miocene time. The Mint Canyon formation is in depositional contact with the Pelona Schist series. The Mint Canyon beds were deposited along the face of a steep scarp since the contact between these two formations deeps steeply southward. The Mint Canyon beds south of the Le Brun Quadrangle are nearly horizontal indicating that no appreciable tilting has taken place since the Mint Canyon formation was laid down. The sandstone is dominately arenaceous and unconsolidated. Bioitite is a common eonstituent in contrast to hornblende which has hitherto been more abundant. The fresh basal sandstone is olive green but weathers to buff upon exposure. The sandstone is generally massive but shows distinct stratification near the contact in Haskell canyon dipping to the south at 45 degrees. Conglomerate interbeds show little sorting and are made up of fragments of lava, schist, gneiss, granite, quarzite, and sandstone pebbles. An extensive area of Mint Canyon beds lies to the south of the Le Brun Quadrangle. Vertebfate fossils have been collected in this formation and are the basis for describing it as Upper Miocene.

Quaternary Series

Terrace Alluvium--Pleistocene.

Extensive terraces are formed by the dissected alluvium at the head of Texas and Mint Canyons. This material consists entirely of debris from Sierra Pelona Ridge. It contains mostly fragments of schist and quartzite. Some of the material is subrounded but most of it is angular and shows little evidence of transportation. Gravel beds sometimes contain boulders up to several feet in diameter. Evidently this material accumulated on the slopes of Sierra Pelona Ridge where it was deposited by intermittent streams flowing over broad fans. In San Francisquito Canyon there are several well preserved terraces which are probably contemporaneous with the Texas and Mint Canyon terraces. The San Francisquito terraces are made up of a great deal of Pelona Schist but, also, contain

Martinez sandstone and granitic fragments. Sierra Pelona Valley is a large fan which is now undergoing dissection especially near the southern boundary of the area.

Alluvium recent.

Above the gorge of Mint Canyon there is a small area where alluvial silts and sandstones have been deposited. The farming district in Sierra Pelona Valley is centered in areas of recent alluvium which have been laid down by the streams dissecting the old terraces. Deposits of stream alluvium are found in Texas, Mint, Haskell, and San Francisquito Canyons. Lime cemented stream conglomerates are frequently encountered over the area, and similar deposits are in process of consolidation at the present time.

MICROPHOTOGRAPHS

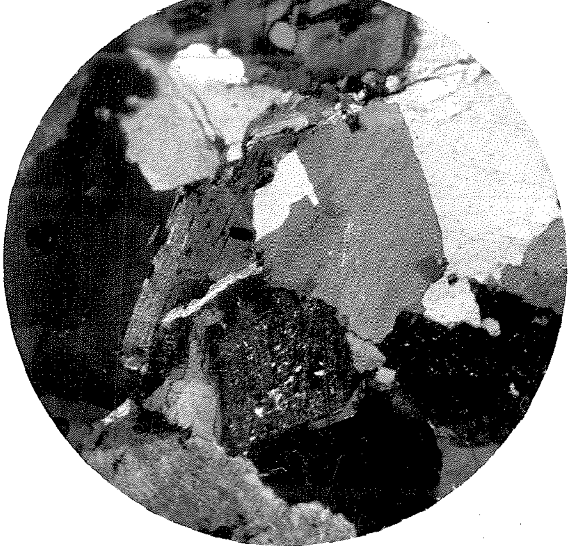


Fig. 22. Quartz Monzonite.

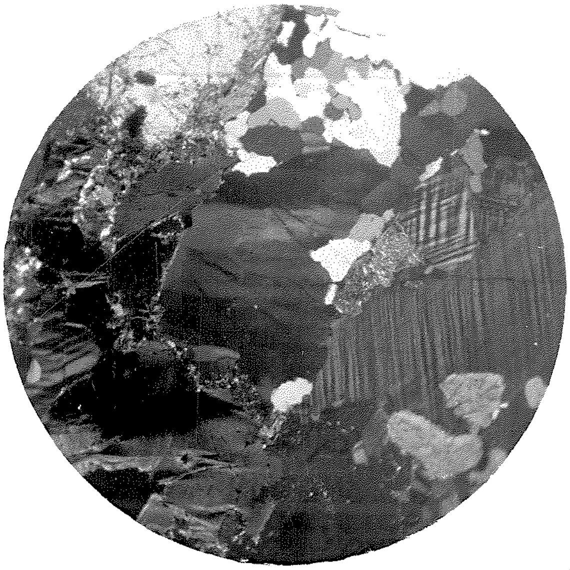


Fig. 23. Microcline-Biotite Gneiss. Note unusual pericline twinning.

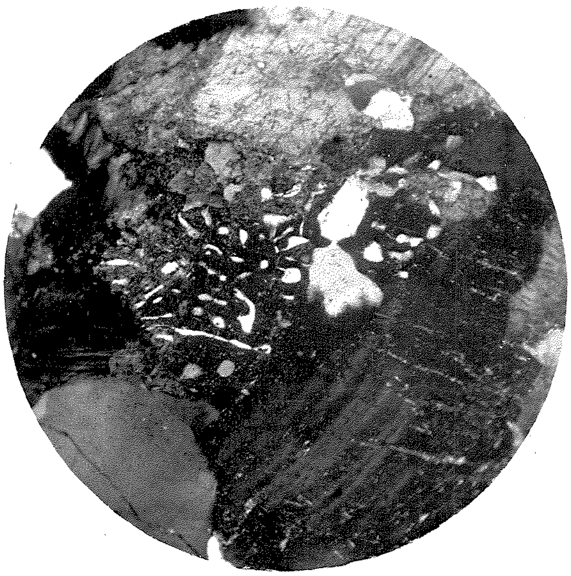


Fig.24. Micmocline-Biotite Gneiss showing perthitic intergrowth between quartz and microcline.

Fig. 25. Igneous rock from fault plane. Note altered feldspar.

Fig. 26. Granodiorite. Observe Albite twinning on andesine.

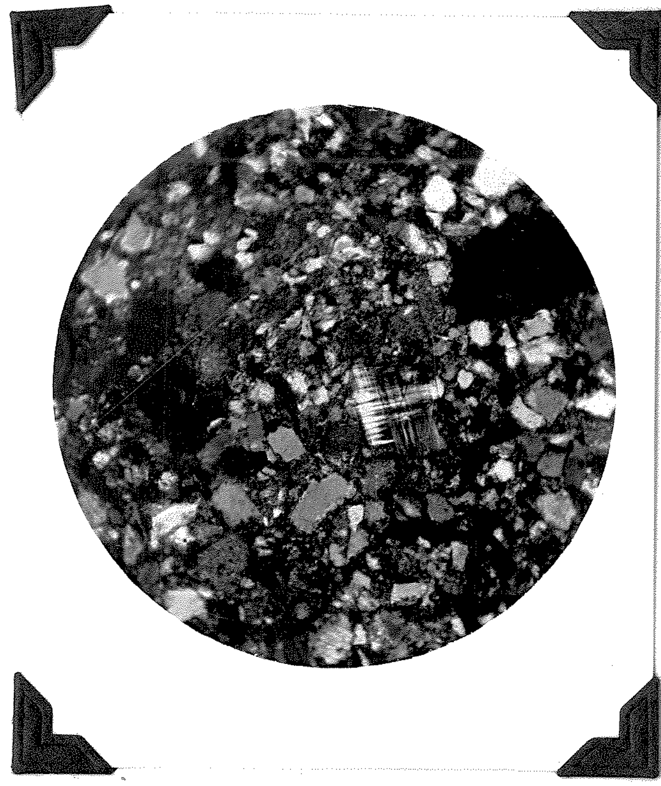


Fig. 27. Sespe sandstone. Note pericline twinning on fragmental grain.

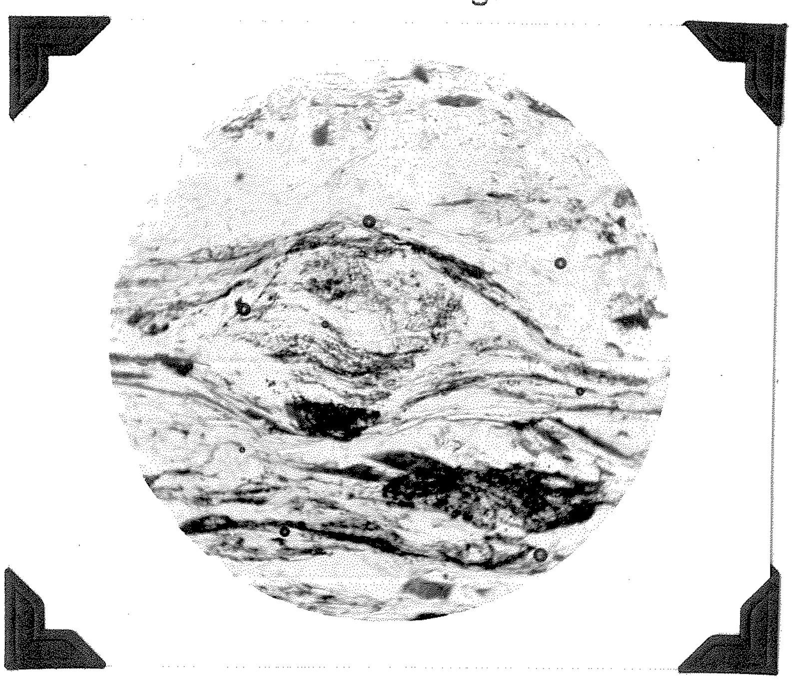


Fig. 28. Graphite Schist.

STRUCTURAL GEOLOGY

General Features.

Structurally Sierra Pelona Ridge marks the beginning of the transverse structures of the central Coast Ranges. It is also closely related to the Tehachapi Mountains and the so-called"structural knot" of California. For these reasons, the structural relationships are complex. Faulting is the dominant structural feature. Huge slabs of granite have been thrust over Tertiary sediments. Possibly three distinct periods of faulting are envolved. The base of the southern slope of Sierra Pelona Ridge marks the position of a normal fault which can be traced across the area. At its western end in Texas and Upper Mint Canyons, this fault is closely related to a complex mosaic of faults which appear to have proceeded it. These structures probably date back to Miocene time and are intimely connected with the San Andreas Rift which is believed to have come into existence at about the same time. The physical relationships of these faults indicate that they proceed the present period and are no longer active.

There are other important structures in the sedimentary formations. The wedge of Martinez sediments is a homocline. In Texas Canyon, the Vasquez formation gives evidence of an anticlinal structure which is terminated by the Sierra Pelona Fault. Other significant structures were recognized in the field.

The Clearwater Fault Zone.

Fig.29. Clearwater Fault exposed in road cut, San Francisquito Canyon.

Fig. 30. Cherry Canyon looking west along the Clearwater Fault.

-Photo by Judson

Fig. 31. Clearwater Fault at the eastern edge of the Mint Canyon Quadrangle showing the San Andreas Rift in distance.

Bee Canyon Fault.

The Bee Canyon Fault seperates the Martinez and Sespe formations. This fault is a steep fault, but undoubtedly of the overthrust type, dipping northward at 60 degrees with Martinez sandstone riding over Sespe beds. A remarkable window showing this relationship is present on the west side of San Francisquito Canyon opposite the Public Camp Ground. The fault apparently steepens westward and at certain localities is almost vertical. Clements, working in the Tejon Quadrangle, observed that the Bee Canyon Fault was a steep normal fault. Numerous fault notches mark the line of this fault. Gouge and breccia can be collected along the fault plane. Slickensided and sheared fragments can be occassionally picked up in following the fault. By the aqueduct in Bee Canyon as much as 10 feet of gouge marks the fault. About one mile from the mouth of Bee Canyon, the Bee Canyon Fault is terminated by the San Francisquito Fault. The general pattern of the two faults suggests that the Bee Canyon fault is the younger; however the small angle at which the two faults run together is possible evidence of bifurcation.

The San Francisquito Fault.

Although the San Francisquito Fault traverses the entire length of Bee Canyon, previous usage requires that this name be applied to the fault seperating the Martinez and Sespe beds. Hitherto no distinction seems to have been applied to designate which fault actually runs through and which fault

Fig. 32. Clearwater Canyon from the west edge of the Le Brun Quadrangle. Cherry Canyon Fault gap on skyline.

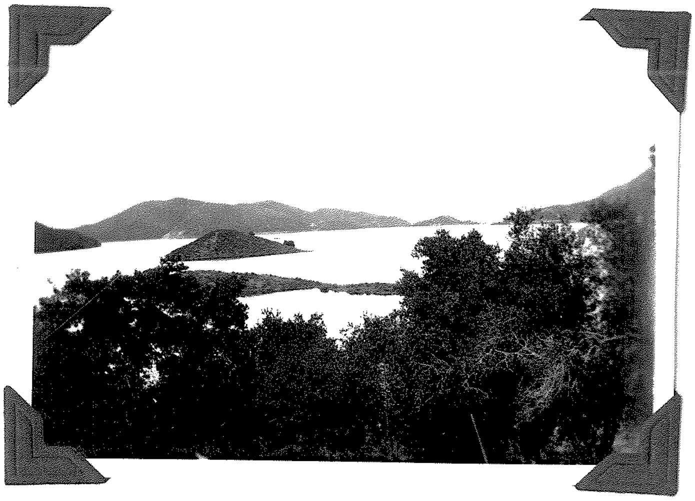


Fig. 33. Bouquet Canyon Reservoir showing islands formed by fault slices.

- Photo by Judson

Fig.34. Jupiter Mountain and Bouquet Canyon Reservoir.

actually runs through and which fault has been cut off. The linear plan of the San Francisquito Fault conforms better with the strike of the Bouquet Canyon Fault and for this reason the name, San Francisquito Fault, is applied. This overthrust marks the northern boundary of the Pelona Schist Series. It carries Sespe beds over schists in San Francisquito Canyon and Martinez beds over the same metamorphics in Bee Canyon. Several slices of rock have been exposed along this fault. Near the head of Bee Canyon, there are several areas of igneous rock which have been carried up along the fault plane. Just east of the termination of the Bee Canyon Fault, several slices of igneous, Martinez,and Sespe rocks are exposed. The Sespe slice is dragged down with respect to the schist at this locality. The Sespe-Pelona Schist Fault dips northward at an angle of 60 degrees, and the Sespe-Martinez Fault dips 85 degrees southward and contains white igneous material. The San Francisquito Fault has a moderately steep dip northward throughout its course, averaging 70 degrees. Southward it has shallower dips. At St. Francis damsite, it dips at a low angle not exceeding 45 degrees. It strikes N 60 degrees E.

In connection with the St. Ffancis Dam investigations, this fault received considerble attention. Ransome first suggested that it was an overthrust. Nickell believed it to be a normal fault. Wills explained the presence of some gouge at the damsite by suggesting that it was weathered schist.

Fig.35. A view along the strike of the Bee Canyon Fault showing slice ridges in distance across reservoir.

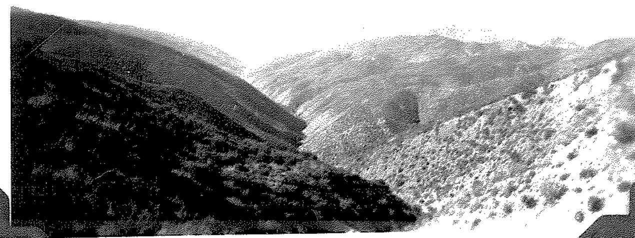


Fig. 36. Bee Canyon. Note the break in the profile of the mature-land to form Bee Canyon.

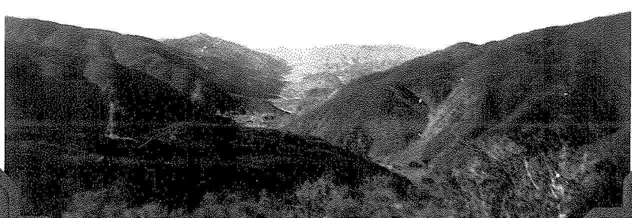


Fig. 37. San Francisquito Fault, San Francisquito Canyon.

Fig. 38. San Francisquito Canyon looking westward along the Bee Canyon Fault.

Clements collected clear proof of the overthrust character of this fault. Simpson says that these faults (Bee Canyon and San Francisquito) dip northward at angles of 10 and 20 degrees and considers that the Bee Canyon Fault cuts off the San Francisquito Fault. As has been already pointed out, the San Francisquito Fault is the linear prolongation of the fault in upper Bee Canyon. Further evidence to support this view is derived from the fact that igneous wedges are found along the San Francisquito Fault on both sides of the point were it intersects the Bee Canyon Fault. Although it is possible that these two faults bifurcate, the writer considers the San Francisquito Fault to be later than the Bee Canyon Fault. It has probably also undergone considerable horizontal displacement in addition to everthrusting. No precise determination of the amount of displacement involved in these thrusts is possible since beds may be missing in the stratigraphic column which were originally present. At least several thousand feet of movement seems to be involved to bring about the present relations. The San Francisquito Fault is cut off by the Clearwater Fault north of Bouquet Canyon Reservoir. Evidently it is earlier than the Clearwater Fault.

The Clearwater Fault.

This is the most evident fault within the area. Everywhere it is marked by fault gaps and by changes of color because of differences in vegatation. On the San Francisquito Canyon road, a zone of gouge 40 feet wide marks the fault. Elsewhere slices of white crystalline rock parallel the fault. The writer considers this white igneous material to represent slices of underlying rock which have been brought up by faulting. There is little evidence to support the belief that this material origniated as intrusions along fault planes. Although some of the rock is fine grained, much of it is medium grained in texture. There is no evidence of assimulation ~~or~~ of the the intrusive origin of this material; furthermore the presence of an intrusive slice with associated sedimentary slices in Bee Canyon is difficult to explain on the basis of an intrusive phenomena.

This fault dips ~~dips~~ approximately 60 degrees north and strikes almost east-west. The Clearwater Fault is a steep overthrust carrying a granite block over Martinez sediments. The only spring within the area is found in Clearwater Canyon on the fault. Although this appears to be the most recent of this series of faults, there is no evidence of recent faulting. It might be well to note the fact that any possible offsets due to different periods of faulting would be obscured by the overthrust masses.

A fault paralleling the Clearwater Fault is located about a quarter mile north of it in the igneous body. This fault is very steep, and it was only with considerable effort that it was traced out. It has little or no topographic expression adding to the difficulty.

Several faults were traced through the Martinez formation until they were lost beneath the reservoir. These faults are all steep and are apparently related to the Clearwater Fault since they join it.

Faults within the Sierra Pelona Schist.

A steep fault has been traced through the schist series. It strikes N 70 degrees E and dips at varying degrees, to the north in Bouquet Canyon and to the south in Haskell Canyon. Local mineralization has taken place, and in Haskell Canyon the fault zone has been prospected for copper. Chrysocolla is found in a 10 foot gouge zone at this locality.

Small faults of minor importance are frequent throughout the Sierra Pelona Schist Series, but they are difficult to trace out.

Texas Canyon Fault Zone.

This mosaic of parallel faults and fault slices, striking roughly N 75 degrees E, is the most unique structural feature found within the Le Brun and Mint Canyon Quadrangles. Most of these faults are vertical and all are steep faults. The attitude on one fault plane showed a dip of north 60 degrees. Others dip slightly to the south. Here also at least three stages of faulting can be recognized. The earliest fault strikes in a direction N 45 degrees W and appears to be cut off by east-west faults. A large fault slice of igneous material has been brought up by this fault where it crosses the canyon.

The later east-west faults form a zone which extends from Sierra Pelona Fault into the igneous complex at the head of the Mint Canyon gorge, a zone two miles wide. Parallel slabs of igneous granitic rocks, microcline-biotite gneiss, and Vasquez beds occur across this zone. Occasionally faults can be made out cutting through these slices parallel to the bouding faults.

Other interesting features are their lens-like character and the unusually thin slices which are brought up. Many of the slices are less than 50 feet across in exposures. Vertical faults are found on both sides of the uplifted blocks. Slices of microcline-biotite gneiss form the raised blocks while blocks of Vasquez sandstone are generally depressed. At least eight seperate slices occur across this zone. In general these slices may be joined with parallel slices along the strike of the bounding faults. Locally, especially near the Sierra Pelona Fault, igneous material is found associated with the lines of faulting.

This series of parallel faults is believed to of the same vintage. They are definitely post-Vasquez and are probably pre-Sierra Pelona Faulting in age. They came into existence before the Sierra Pelona Fault because this zone is cut off at the base of Sierra Pelona Ridge where this fault is located; Furthermore it seems incredible that this mosaic of parallel structures could be the result of extensive bifurcation on the Sierra Pelona Fault. Unfortunately the critical relationships are masked by terraces. It seems probable that this wide zone of faulting is truncated by the Sierra Pelona Fault and that it does not die out under the terraces. Finally, the basal conglomerate of microcline-biotite gneiss indicates the existence of such fault blocks as far back as Vasquez time.

This mosaic of faults is probably related to shearing stresses applied in an east-west direction across the zone. The anticlinal structure of the Vasquez formation is probably the result of a still earlier period of deformation.

The Sierra Pelona Fault.

This fault which appears to related to the most recent period of faulting within the Le Brun and Mint Canyon Quadrangles is located at the base of the southern slope of Sierra Pelona Ridge. It has the greatest topographic expression of any of the faults within the area and forms an imposing scarp when viewed from Mint Canyon. Eastward, the trace of the fault is lost beneath extensive terraces and fan slopes. Sierra Pelona Fault strikes roughly east-west and dips to the south at angles approximateing 60 degrees. It is a steep normal fault. Slickensided surfaces can be observed at several points were the fault plane is exposed. These indicate considerable horizontal movement in conjunction with vertical displacement. Calcareous spring deposits are also found along the trace of this fault.

Since San Francisquito and Clearwater Faults, which form the northern boundary of Sierra Pelona Ridge dip northward and are overthrusts, and Sierra Pelona Fault, which forms the southern boundary of Sierra Pelona Ridge is a normal fault, it is difficult to concieve of this structure as a simple horst. It is improbable that Sierra Pelona Ridge represents simple block faulting, but it is more likely that several episodes of unrelated faulting are involved. The prominent southern face of Sierra Pelona Ridge suggests that Sierra Pelona Fault was the last of these structural lines to show activity.

Several faults bifurcating from the Sierra Pelona Fault delimit an area of igneous rock north of the fault.

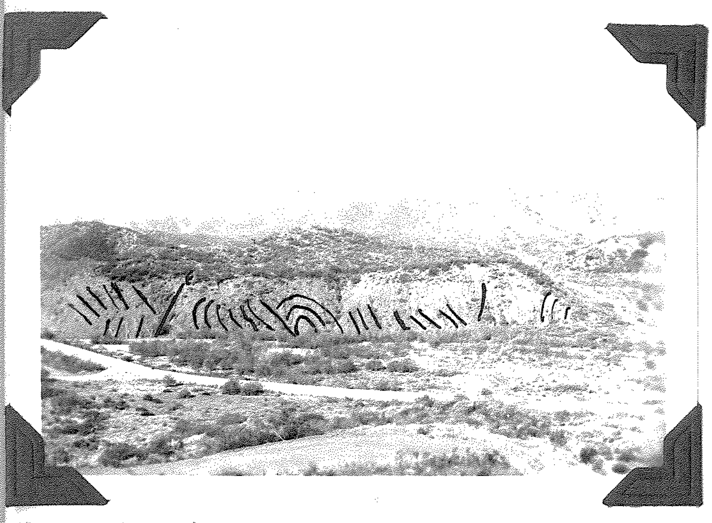


Fig. 39. A complicated structural zone in the Sespe section, San Francisquito Canyon.

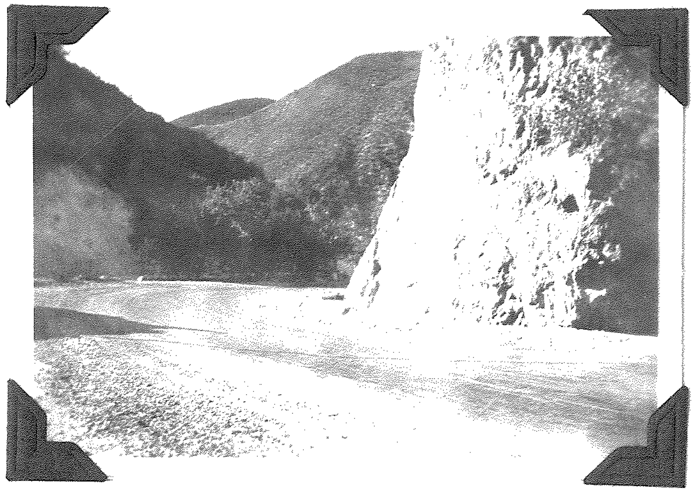


Fig. 40. A slickensided surface, Lower Bouquet Canyon.

At the southern extremity of the area in Sierra Pelona Valley are apparently two parallel faults which have brought up aligned ridges. These ridges are now eroded and form beaded ridges. Although there is good physiographic evidence for these faults, it cannot be confirmed by field evidence since the fault plane is buried beneath the alluvium.

Several zones of brecciated, slickensided, and gouge material were observed south of Mint Canyon. These zones have been indicated on the map as tentative faults.

Structure of the Pelona Schist Series.

The Pelona Schist Series has a general anticlinal structure wich finds its topographic expression on the gently curved summit of Sierra Pelona Ridge. The axis of the anticline is parallel to the ridge. At many localities, this general structure is, however, obscured, by minor complications within the schist.

Structure of the Sedimentary Series.

Martinez Formation.

The Martinez formation is a structural homocline of steeply tilted beds. Locally, some of the beds are overturned. A few minor structures were observed in the field. Several faults were mapped through the formation. A small area of complicated structure is located on the top of a ridge one-half way up Bee Canyon. Here several minor faults run together. A small anticline which is broken by a fault was observed near the head of Cherry Canyon.

Sespe Formation.

The Sespe formation is highly folded and faulted. The narrowness of the section is probably responsible for the complicated structure which may well be related to drag effects on the bounding faults. Several anticlines and synclines are found across the section. Many of the differences of strike and dip are due to initial differences of attitude which are reflected in the lens-like nature of the deposits.

Vasquez Formation.

This formation forms a large structural anticline which has been cut off by the Sierra Pelona Fault. The Vasquez beds form the southern limb of this structure and dip at varying degrees southward. Local anomalous dips are the result of subsequent faulting.

GEOLOGIC HISTORY

The earliest record of geologic processes foundin the Le Brun and Mint Canyon Quadrangles is the deposition ef a sedimentary series. This series was subsequently injected and metamorphosed forming the Sierra Pelona Schist Series. These events probably took place in pre-Cambrian time. Later intrusions of pre-Cretaceous and Jurassic age appear to have formed large igneous structures in the northern and southern parts of the area. In Paleocene time, a 7000 foot section of sediments was laid down forming the Martinez beds. These beds were later tilted probably before Oligocene time when the Sespe formation was deposited in a fault basin occasionally open to the sea. A short while later the Vasquez formation was laid down in another fault basin to the south. Soon afterward the Bee Canyon Fault came into existence as well as the earlieát faults in the Texas-Mint Canyon zone. A short while following this event, Pelona Schist was faulted up exposing this series for the first time. Fragments of this material accumulated on steep slopes and were deposited in the Mint Canyon formation. This period probably marked the beginning of thrusting on the San Francisquito Fault. Perhaps, somewhat later, the wide zone of parallel faults in Texas and Mint Canyons came into existence. Probably at about the same time the Clearwater fault became active carrying the igneous mass southward. Finally, the Sierra Pelona Fault uplifted the southern border of Sierra Pelona Ridge. This event inaugurated the erosional cycle which developed the matureland. This cycle has been rejuvenated and has passed through several subsequent stages.

The sequence of geologic events is approximately as follows:

1. Deposition, injection, and metamorphism of sediments forming the Pelona Schist Series (Pre-Cambrian).
2. Intrusions of igneous rocks (Pre-Cretaceous and Jurassic).
3. Martinez deposition and tilting (Paleocene).
4. Sespe and Vasquez deposition initiating fault activity on the Bee Canyon Fault and within the Texas-Mint Canyon zone (Oligocene to Middle Miocene).
5. Mint Canyon deposition and movement along the San Francisquito Fault(Middle Miocene).
6. Activity on the Clearwater Fault followed by uplift along the Sierra Pelona Fault inaugurating the erosional cycle(Pliocene?).
7. Development of the matureland and subsidence of seismic activity(Pleistocene).
8. Intermediate stages in the erosional history including deposition of old terraces and fanglomerates.
9. Recent alluvial deposition and the attainment of the present topography.

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